COASTAL AND HYDRAULICS LABORATORY
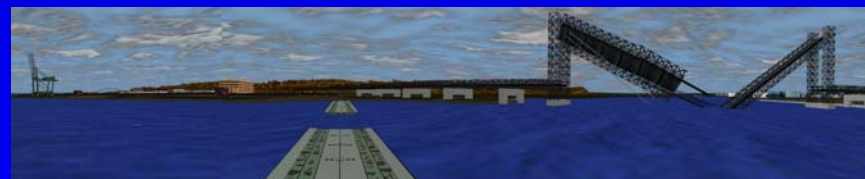
WATERSHED SYSTEM 2003 CONFERENCE
PORTLAND, OREGON
14 MAY 2003

1:120 physical model - Chicago Harbor

SANDRA K. KNIGHT
TECHNICAL DIRECTOR
COASTAL AND HYDRAULICS LABORATORY
ENGINEER RESEARCH AND DEVELOPMENT CENTER
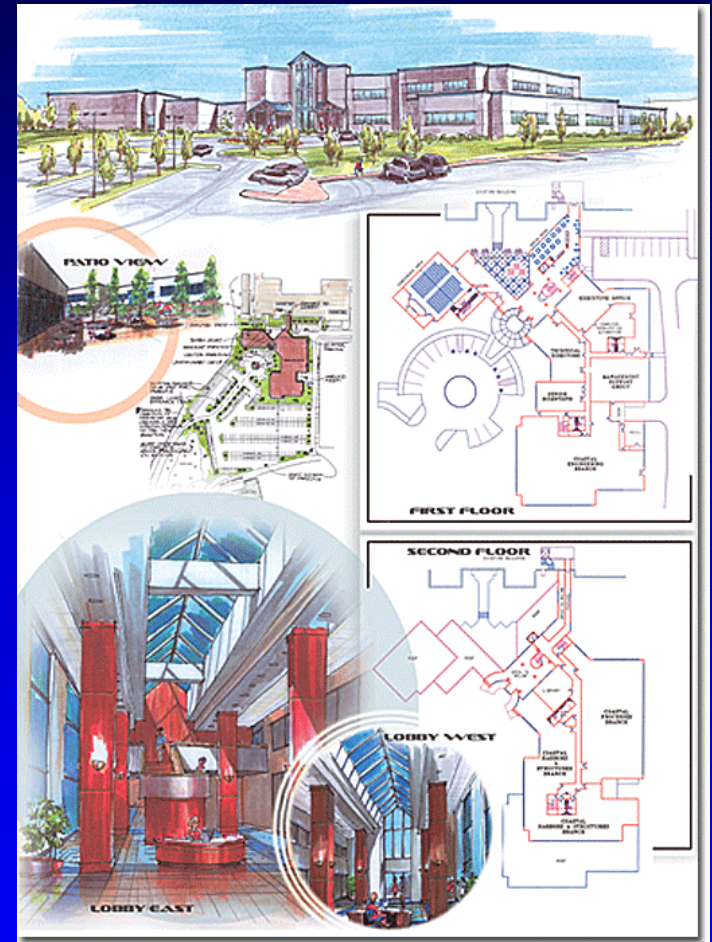
**US Army Corps
of Engineers**

Research and Development

AGENDA

- **LABORATORY OVERVIEW**
- **MISSIONS**
  - Navigation
  - Flood Control
  - Groundwater / Hydrology
  - Military Support
- **TOOLS AND FACILITIES**
  - Physical Models
  - Field Data
  - Hydrodynamic Modeling
  - Ship / Tow Simulator
- **CONCLUSION**

US Army Corps of Engineers

Research and Development

LABORATORY OVERVIEW

LABORATORY OVERVIEW

Hydraulic work focuses on understanding and improving USACE water-related projects including

- **Navigation**
- **Flood control**
- **Hydraulic structures**
- **Reservoir operations**

Coastal engineering research focuses on providing a better understanding of waves, currents, winds, and other natural shoreline forces

- **Shore and beach erosion control**
- **Flooding and storm protection**
- **Coastal dredging**
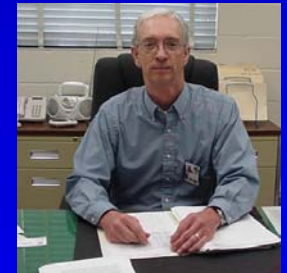- **Physical components of coastal environmental problems**

LABORATORY OVERVIEW

WORKLOAD

- **Gross annual revenues of approximately $62 million**
- **75 percent civil works, 25 percent military**
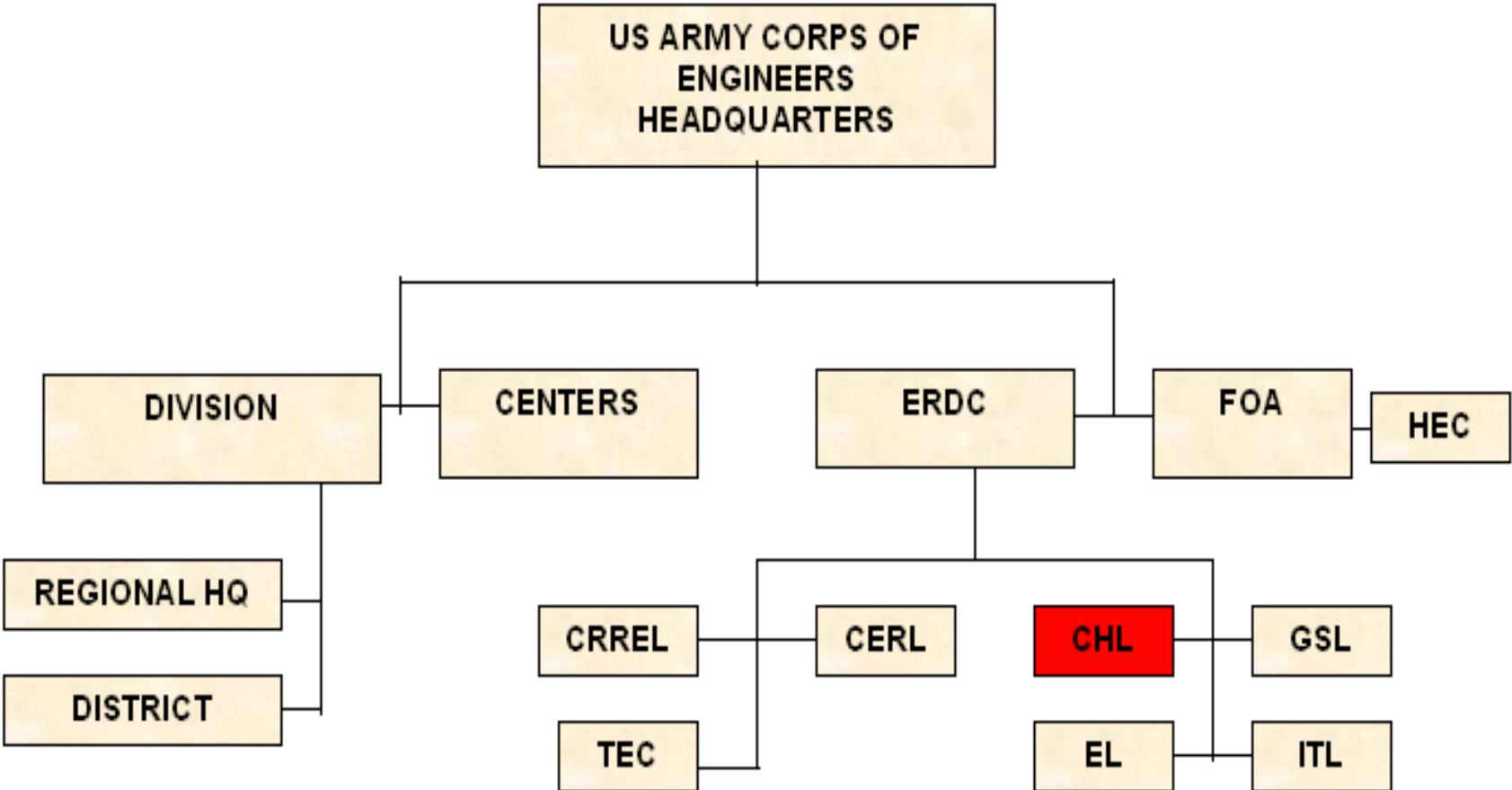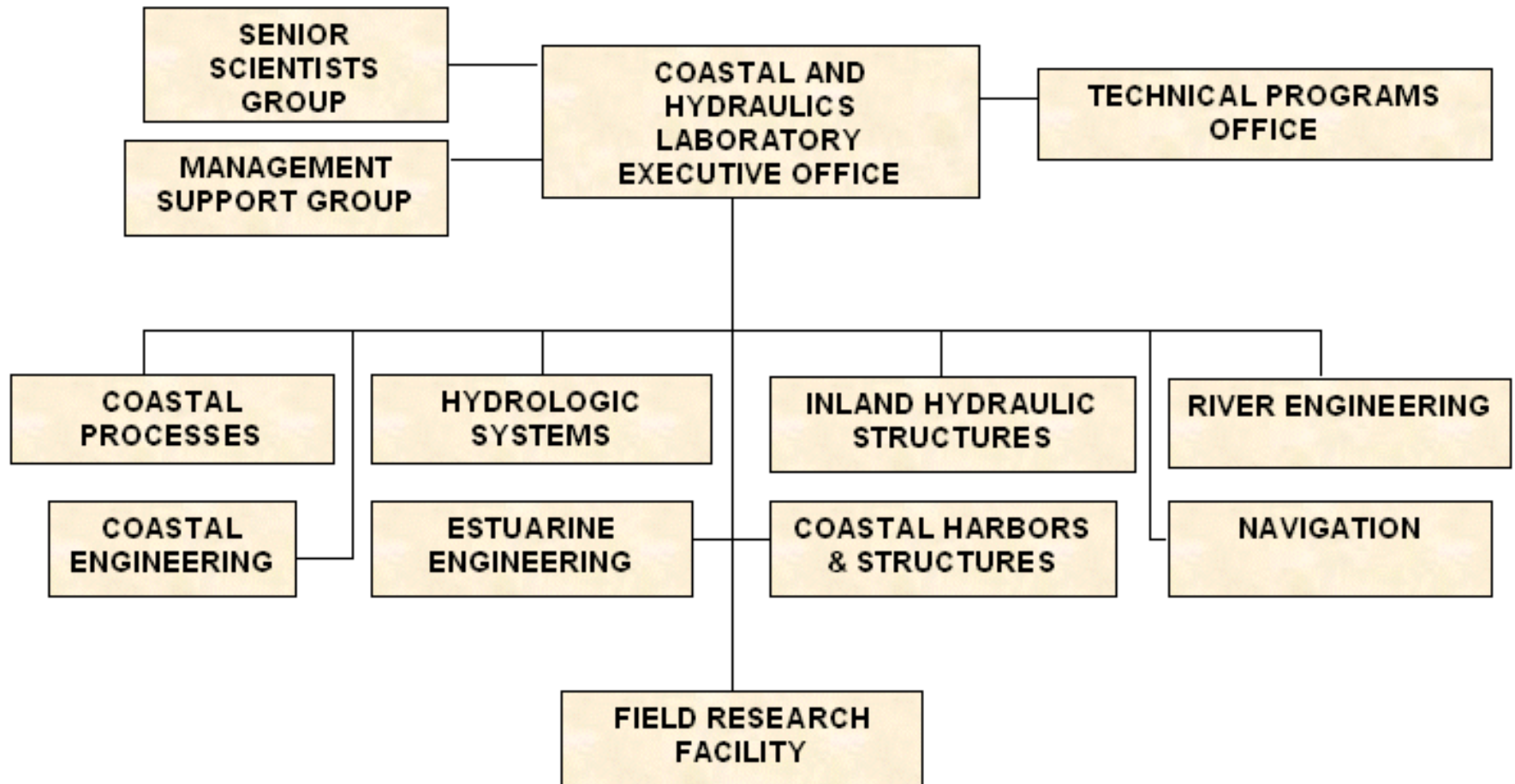- **67 percent reimbursable, 33 percent direct allotted**

STAFF

- **Approximately 260 permanent civilian staff members**
  - **46 Doctorate degrees**
  - **85 Masters degrees**
- **Technical expertise**
  - **Various engineering disciplines**
  - **Computer scientists**
  - **Geologists**
  - **Mathematicians**
  - **Physicists**
  - **Oceanographers**

US Army Corps of Engineers

LABORATORY OVERVIEW

US Army Corps
of Engineers

Research and Development

LABORATORY OVERVIEW

US Army Corps
of Engineers

Research and Development

MISSIONS

NAVIGATION

MISSION

Provide USACE with tools and technology to Improve the navigation system's functional performance, preserve and enhance environmental quality of our waterways, harbors, and ports reduce unit costs, and improve safety.

MARINE TRANSPORTATION SYSTEM (MTS)

- **MTS employs 13M people, provides $700B to the national economy, and moves military forces and materials.**

- **R&D is producing new technologies and advancing existing technologies to ensure a high performance navigation system and maximize opportunities for environmental improvement.**

NAVIGATION

PROGRAMS

- **Coastal Inlets Research Program (CIRP)**

- **Dredging Operations and Environmental (DOER)**

- **Dredging Operational Technical Support (DOTS)**

- **ECDIS**

- **Monitoring Completed Navigation Projects (MCNP)**

- **Navigation Systems**

- **Regional Sediment Management (RSM)**

FLOOD CONTROL

MISSION

Reduce, through an integrated program of structural and non-structural means, the adverse economic, social, and environmental consequences to the Nation resulting from flooding of riverine and coastal sources

FLOOD AND COASTAL STORM DAMAGE REDUCTION

- **USACE operates 383 major lakes and reservoirs, maintains 8,500 miles of levees, and has over 100 coastal storm damage reduction and related projects**

- **CHL conducts extensive research on both coastal shore protection and inland flood damage reduction:**
  - **Channel restoration**
  - **Channel sedimentation**
  - **Bank protection methods**
  - **Ice impacts on flood control and navigation structures**
  - **Impacts of climate changes**

US Army Corps
of Engineers

Research and Development
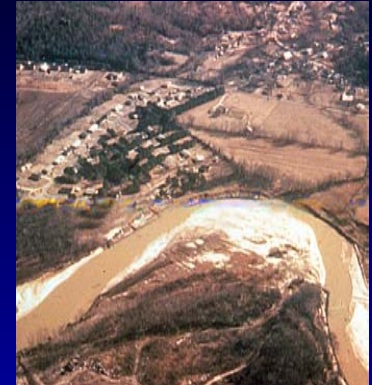
FLOOD CONTROL

LOS ANGELES COUNTY DRAINAGE AREA (LACDA)

- Study conducted to improve flood carrying capacity in a highly urbanized area
- Saved over $350 million
- Flood insurance premium savings of $120 million per year

CORE-LOC

- Revolutionary concrete armoring unit designed to protect navigation structures (breakwaters, jetties) from harsh wave climates
- Placed in a single layer, resulting in
  - Significant reduction in on-slope concrete volume
 - Potential savings over 50 percent of cost associated with other concrete armor units


US Army Corps of Engineers

GROUNDWATER / HYDROLOGY

GROUNDWATER / HYDROLOGY MISSION

CHL conducts research and development in the general area of computational hydrology, including hydro-informative systems for military and civil works applications in surface water, groundwater, and watersheds.

These systems address the multi-dimensional and transient interactions between surface water and groundwater that are essential for complex, comprehensive hydrologic studies.
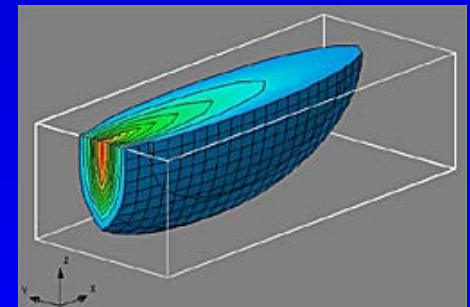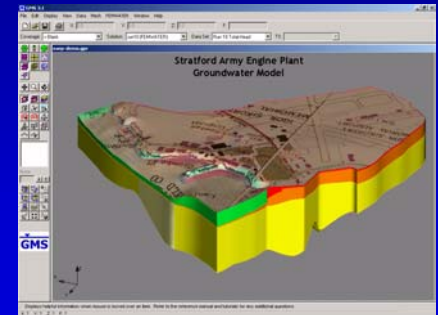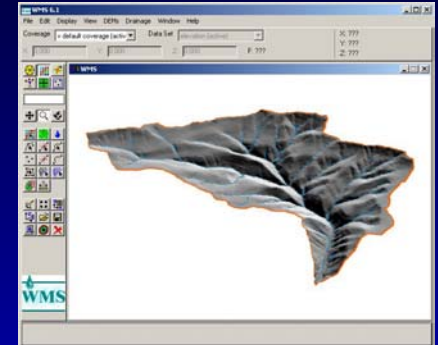
MILITARY SUPPORT

MILITARY SUPPORT MISSION

CHL supports mission planning and execution for both Army and Joint tactical and strategic operations by providing expertise in applications that affect mobility and water supply.

These efforts give the Warfighter the maximum benefit of detailed analysis to assist in making critical and far reaching military decisions.

US Army Corps of Engineers

Research and Development
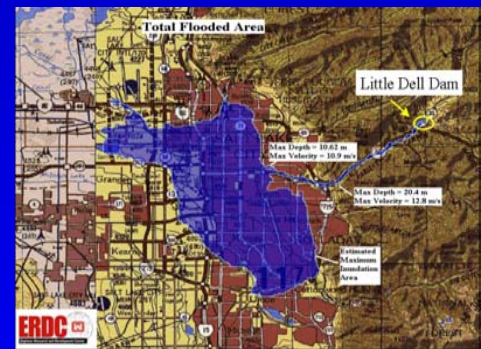
MIILITARY SUPPORT

COASTAL INTEGRATED THROUGHPUT MODEL

- **Assesses throughput capabilities for logistics over the shore operations involving bare beach or austere small ports**
- **Allows commanders to rapidly assess impacts and evaluate available courses of action involving ship to shore cargo/equipment transfer when large seaports are damaged or denied**

LOTS Throughput Prediction

RAPID RESPONSE DAM BREACH ANALYSIS

- **Provides information on**
  - **Maps of estimated inundation area**
  - **Estimated maximum water depth and velocity**
  - **Time of arrival for flood wave, flood duration**
  - **Improves emergency flood fighting operations by identifying affected areas and flood characteristics**

US Army Corps of Engineers

MILITARY SUPPORT

WARFIGHTER / OPERATIONAL SUPPORT

Recent areas of interest include:

IRAQ, AFGHANISTAN, KOREA, ALBANIA, BOSNIA, MOZAMBIQUE, KOSOVO

- **Floodplain Analysis**
- **Base Camp Evaluation**
- **River Forecasting**
- **River Stage Monitoring**
- **Dam Breach Analysis**
- **Hydrologic Modeling**
- **Analysis of River Crossings**

TOOLS AND FACILITIES
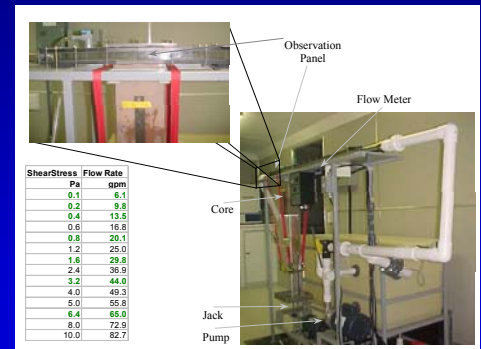
PHYSICAL MODELING CAPABILITIES

ESTEX FLUME

- Used in unsteady, non-uniform flow and transport research in all hydrographical zones
- Advances understanding of hydrodynamic processes important to water resource conservation and management

SEDFLUME

- Estimates erosion rates of fine-grained and mixed fine/coarse grained sediments

LONGSHORE SEDIMENT TRANSPORT (LST) FACILITY

- Provides greater understanding of sand transport processes, improved relationships for estimating LST, and ability to quantify uncertainty in LST predictions

US Army Corps of Engineers

Research and Development

PHYSICAL MODELING CAPABILITIES

LOS ANGELES / LONG BEACH HARBOR MODEL

- Reproduces entire harbor area, shoreline from Point Fermin to Huntington Beach, and underwater contours out to –300 feet
- Applications in studies of harbor oscillation, ship motion, harbor circulation, and water quality

MULTI-DIRECTIONAL SPECTRAL WAVE GENERATOR FACILITY

- Provides realistic 3D waves in a controlled, laboratory environment
- Numerous applications including:
  - Wave transformation
  - Fixed and floating breakwaters
  - Ship motions and underkeel clearance
  - Wave-current interactions

US Army Corps of Engineers

PHYSICAL MODELING CAPABILITIES

LOCK FILLING AND EMPTYING SYSTEMS

LOCK APPROACH GUIDANCE

- **Used to investigate the current phenomena in upper lock approaches with a variety of guide walls.**

- **Results provide design guidance for upper lock approaches, including parameters for the geometric layout of upper approach guard walls.**

J.T. MYERS LOCKS AND DAM MODEL

- **Used to identify and develop a cost effective and efficient filling and emptying system for 600 ft lock extension**


Extended Lock

J T Myers
L&D

US Army Corps of Engineers

FIELD DATA

FIELD RESEARCH FACILITY (Duck, North Carolina)
- **Instruments record wave, winds, tides, and currents**
- **Recent projects include:**
  - **STORM (measure near shore processes related to**
  - **sediment transport during storms)**
  - **SHOWEX (study properties and evolution of**
  - **surface gravity waves)**

SHOALS (Mobile, Alabama)
- **Rapidly and accurately measures seabed and topographic elevations**
- **Mobile and flexible system, making a rapid response to evolving survey needs**
- **Covers large areas quickly and economically**
- **Rapid assessment of port and waterway conditions and obstructions after storms or other disasters**

**US Army Corps of Engineers**
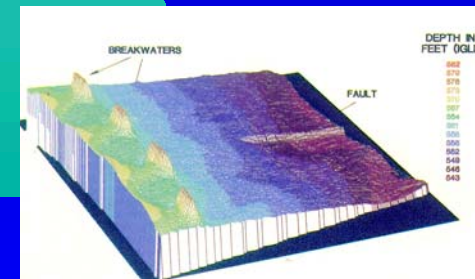
FIELD DATA

## OTHER FIELD COLLECTION CAPABILITIES

- **OPERATIONS AND ANALYSIS GROUP**
  - **Develop and test coastal oceanographic equipment, instrumentation, and sensors which specialize in the measurement of waves, tides, and currents.**
  - **Deployment, operation, and maintenance of coastal data acquisition systems.**

- **HYDRAULIC PROCESSES ANALYSIS SYSTEM (HYPASS)**
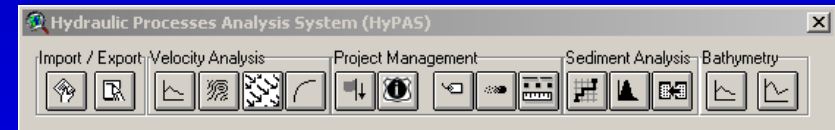
- **ACOUSTIC DOPPLER CURRENT PROFILER**

US Army Corps of Engineers
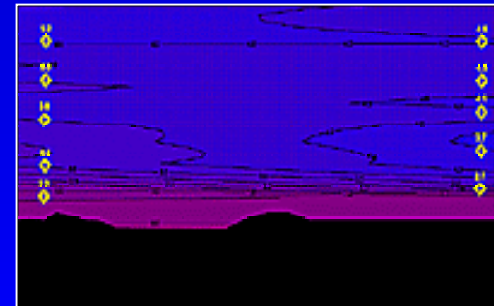
HYDRODYNAMIC MODELING

XMS

- **Consistent, re-useable user interface and data structures for**
  - **GMS (Groundwater Modeling System)**
  - **SMS (Surface water Modeling System)**
  - **WMS (Watershed Modeling System)**
- **Model results easily exchanged among systems**
- **Facilitates comparisons of modeling approaches**

POOL 8 - LOCATION MAP

YEARS
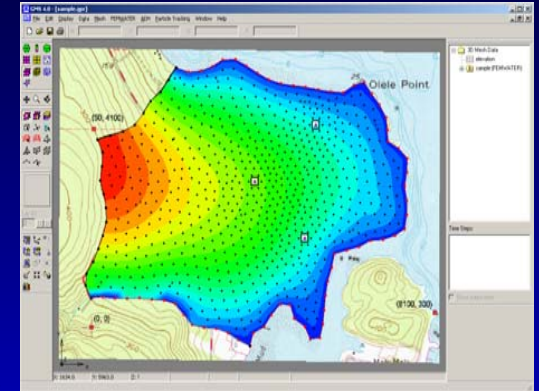
SHIP/TOW SIMULATOR

SPECIFICATIONS / CAPABILITIES

- **Simulates ports, harbors, inland waterways, and any other maritime environment**

- **Models accurately portray currents, wind and wave conditions, shallow water effects, bank forces, ship handling, ship to ship interaction, fender forces, anchor forces, and tug assistance**

APPLICATIONS

- **War game simulations**

- **Develop a digital database of all major US harbors and waterways for use in determining threat potential or simulate ways to counteract a terrorist threat**
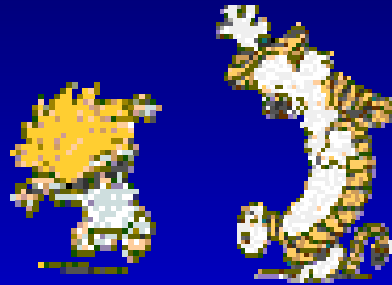

US Army Corps of Engineers

Research and Development

Upcoming Program Reviews

- **Strategic Programs: Baltimore, June 24-26, 2003**
    - **TOWNS**
    - **RSM**
    - **SMART**
    - **CDF/Informatics**
- **Navigation and Flood Control Tactical Program Chicago, July 22-24**
    - **Navigation Systems**
    - **Flood and Coastal Systems**
    - **Coastal Inlets Program**
    - **Coastal Field Data Collection**

CONCLUSION

ANY QUESTIONS?

SANDRA K. KNIGHT, PhD, PE
COASTAL AND HYDRAULICS LABORATORY
ENGINEER RESEARCH AND DEVELOPMENT CENTER
VICKSBURG, MISSISSIPPI

EMAIL: Sandra.K.Knight@erdc.usace.army.mil
TELEPHONE: (601) 634-2693
http://chl.wes.army.mil/

**US Army Corps
of Engineers**

Research and Development